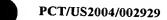
Claims:

- 1. A method of preparing metal chalcogenides from elemental metal and metal compounds, the method comprising
 - a. providing at least one chalcogen;
 - b. providing at least one element from periodic table groups 13-15;
 - c. providing at least one elemental metal or metal compound;
- d. combining and heating the chalcogen, the group 13-15 element and the metal at sufficient time and temperature to form a metal chalcogenide.
- 2. The method of claim 1 wherein the chalcogen and group 13-15 element are combined before combination with the metal.
- 3. The method of claim 1 wherein the element from groups 13-15 is B, Al, Ga, In, Si, Ge, Sn, Pb, P, As, Sb, Bi or a combination thereof.
- 4. The method of claim 1, wherein the metal compound is selected from TiO₂, V₂O₅, MnO₂, Fe₂O₃, Fe₃O₄, NiO, NbO, Nb₂O₅, MoO₂, MoO₃, RuO₂, Wo₃, Y₂O₃, Ce₂O₃, Nd₂O₃, Sm₂O₃, Eu₂O₃, Tb₄O₇, or Er₂O₃.
- 5. A method of preparing metal sulfides and polysulfides from metal oxides, the method comprising
 - a. providing boron, pure sulfur, and pure metal oxide powder;
 - b. placing the boron and sulfur in a first tube;
 - c. placing the metal oxide powder in a second tube;
 - d. placing the two tubes into a larger container;
 - e. evacuating and sealing the container;
 - f. gradually heating the container to about 400-900 °C; and
 - g. keeping the container at that temperature until little or no boron remains.
- 6. The method of claim 5, wherein step a. utilizes as a metal oxide the compound Nd₂O₃, from which is synthesized NdS₂, and step f. heats the container to about 450 °C.

- 7. The method of claim 5, wherein step b. comprises placing a stoichiometric excess of sulfur into the first silica tube.
- 8. The method of claim 5 step a., wherein sulfur can be replaced by selenium or tellurium.
- 9. A kit comprising:
 - a. boron;
 - d. a chalcogen; and optionally
- e. an elemental metal or a metal oxide, two small tubes and a larger container capable of holding the tubes, the container further being capable of being sealed;
- 10. A method of preparing ultralong TaS₃ nanowires from tantalum metal, the method comprising
 - a. providing at least one piece of tantalum;
 - b. providing and placing boron and sulfur in a first tube;
 - c. placing the tantalum piece in a second tube;
 - d. placing the two tubes into a container;
 - e. evacuating and sealing the container;
 - f. gradually heating the container to about 300-600 °C; and
 - g. cooling the container to room temperature.
- 11. The method of claim 10 wherein the sulfur of step b. is replaced with selenium to produce tantalum triselenide.
- 12. A battery comprising TaS₃ as a positive anode.
- 13. A method of preparing indium sulfide (In₂S₃) from In₂O₃, the method comprising
 - a. providing boron, pure sulfur, and pure In₂O₃;
 - b. placing the boron and the sulfur in a first tube;
 - c. placing the In₂O₃ in a second tube:



- d. placing the two tubes into a container;
- e. sealing the container;
- f. gradually heating the container to about 400-900 °C;
- g. keeping the container at that temperature for about two days or until little boron remains; and
 - h. allowing the container to cool.
- 14. A method of preparing lead sulfide (PbS) from PbO, the method comprising
 - a. providing boron, pure sulfur, and pure PbO;
 - b. mixing and placing the boron and the sulfur in a first tube;
 - placing the PbO in a second tube;
 - d. placing the two tubes into a larger container;
 - e. evacuating and sealing the container;
 - f. gradually heating the container to about 400-900 °C;
- g. keeping the container at that temperature for about two days or until little boron remains,

whereby the PbO turns into PbS.

- 15. The method of claim 14, wherein the pure sulfur of step a. is replaced with pure tellurium to produce PbTe.
- 16. A method of preparing KInS₂ from K₂CO₃ and In₂O₃, the method comprising
 - a. providing boron, pure sulfur, pure K₂CO₃ and pure In₂O₃;
 - b. placing the boron and the sulfur in a first tube;
 - c. placing the K₂CO₃ and In₂O₃ in a second tube;
 - d. placing the two tubes into a larger container;
 - e. evacuating and sealing the container;
 - f. gradually heating the container to about 500-700 °C; and
- g. keeping the container at that temperature for about two days or until little boron can be seen in the first tube.

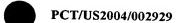
- 17. A method of preparing NaInS₂ from NaF and In₂O₃, the method comprising
 - a. providing boron, pure sulfur, pure NaF and pure In₂O₃;
 - b. placing the boron and the sulfur in a first tube;
 - c. placing the NaF and In₂O₃ in a second tube;
 - d. placing the two tubes into a larger container;
 - e. evacuating and sealing the container;
 - f. gradually heating the container to about 400-600 °C; and
- g. keeping the container at that temperature for about three days or until little boron remains.
- 18. The method of claim 17, wherein the sulfur of step a. is replaced with selenium to produce NaInSe₂.
- 19. A method of preparing NaBiS₂ from NaBiO₃, the method comprising
 - a. providing boron, pure sulfur and pure NaBiO₃;
 - b. placing the boron and the sulfur in a first tube;
 - c. placing the NaBiO₃ in a second tube;
 - d. placing the two tubes into a larger container;
 - e. evacuating and sealing the container;
 - f. gradually heating the container to about 400-600 °C; and
- g. keeping the container at that temperature for about three days or until little boron remains.
- 20. A method of preparing semiconducting chalcogenide nanoparticles and controlling sizes and morphologies in solution, the method comprising
 - a. providing at least one metal compound;
 - b. providing at least one chalcogen
- c. providing at least one element selected from the periodic table groups 13-15 (B, Al, Ga, In, Si, Ge, Sn, Pb, P, As, Sb and Bi); and
- c. mixing the metal compound, the chalcogen and the element in a solution at sufficient temperature and time to produce precipitate.

- 21. A method of preparing CdSe nanocrystals and controlling their size, the method comprising
 - a. providing pure B₂Se₃ dissolved in an amine;
 - b. providing pure CdCl₂ dissolved in an amine;
 - c. mixing the two solutions; and
- d. heating the resulting solution to a temperature in the range of about 50 to 250 °C for selected reaction periods,

whereby the CdSe nanocrystals form and their size varies with the temperature and reaction period.

- 22. The method of claim 21 wherein the heating in step d. is performed in a conventional oven or a microwave oven.
- 23. The method of claim 21, wherein the mixture is heated to 60 °C for 30 minutes in a conventional oven, to produce an average diameter of 2.3 nm.
- 24. The method of claim 21, wherein the mixture is heated to 60 °C for two hours in a conventional oven, to produce an average diameter of 3.4 nm.
- 25. The method of claim 21, wherein the mixture is heated to 135 °C for 5 seconds in a microwave, to produce an average diameter of 5.0 nm.
- 26. The method of claim 21, wherein the mixture is heated to 150 °C for 30 seconds in a microwave, to produce an average diameter of 5.4 nm.
- 27. The method of claim 21, wherein the mixture is heated to 200 °C for overnight in a conventional oven, to produce an average diameter of 11 nm.
- 28. The method of claim 21, wherein the mixture is heated to 150 °C for 30 seconds in a microwave, to produce an average diameter of 12.8 nm.

- 29. A method of preparing CdS nanocrystals of controlled size, the method comprising
 - a. providing pure B₂S₃ dissolved in an amine;
 - b. providing pure CdCl₂ dissolved in an amine;
 - c. mixing the two solutions; and
- d. heating the resulting solution to a temperature of about 100 °C for 40 seconds by microwave irradiation.
- 30. A method of preparing ZnSe nanocrystals of controlled size, the method comprising
 - a. providing pure B₂Se₃ dissolved in an amine;
 - b. providing pure ZnCl₂ dissolved in an amine;
 - c. mixing the two solutions; and
- d. heating the resulting solution to a temperature 100 °C for 40 seconds by microwave irradiation.
- 31. A method of preparing PbSe nanocrystals of controlled size, the method comprising
 - a. providing pure B₂Se₃ dissolved in an amine;
 - b. providing pure PbCl₂ dissolved in an amine;
 - c. mixing the two solutions; and
- d. heating the resulting solution to a temperature 100 °C for 40 seconds by microwave irradiation.
- 32. A method of functionalizing the surface of semiconducting nanoparticles, the method comprising
 - a. providing at least one metal compound;
- b. providing one chalcogenide having a cation selected from groups 13 15 (B, Al, Ga, In, Si, Ge, Sn, Pb, P, As, Sb and Bi);
 - c. dissolving the chalcogenide in a first solution;
 - d. dissolving the metal compound in a second solution;
- e. providing and dissolving a functional capping agent in at least one of the first or second solution; and



- f. combining all the solutions; and
- g. maintaining the combined solution at a proper temperature for an appropriate time.
- 33. The method of claim 32, wherein the first and second solutions are the same.
- 34. A method of preparing CdSe nanocrystals of controlled size, the method comprising
- a. providing pure B₂Se₃ dissolved in a polar solvent and 1,3-dimethyl-2-imidazolidinone at about a 1:50 mole ratio;
- b. providing pure CdCl₂ dissolved in the polar solvent and 1,3-dimethyl-2-imidazolidinone at about a 1: 50 mole ratio;
 - c. mixing the two solutions; and
- d. heating the resulting solution to a temperature of about 70 °C for about 30 minutes in a conventional oven.